UNITED STATES PATENT APPLICATION FOR

CONFIGURING DEVICES USING SERVER RESPONSES

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BACKGROUND OF THE INVENTION

Field of Invention

The present invention pertains to the field of configuring devices. More particularly, this invention relates to configuring devices using server responses.

Art Background

A wide variety devices have behaviors which are governed by a configuration for the device. The process of setting or altering the configuration of a device is often referred to as configuring the device. For example, a measurement device may be configured to obtain a measurement at a particular time or at particular periodic intervals. As another example, a signal generator device may be configured to generate a signal having a particular frequency and/or amplitude. These are only a few examples of devices which may be configured and numerous others exist.

It is common for devices to be placed at relatively remote physical locations. One prior method for configuring such a remote device is to provide a computer system such as a personal computer at the remote location. The computer system is usually provided with a customized hardware/software interface for configuring the remote device. Typically, the computer system obtains configuration information pertaining to the remote device via a telephone line from a control center for the device and then configures the remote device accordingly.

Typically, the specialized hardware/software on the remote computer system and central computer system must be adapted to a variety of different devices. Unfortunately, such customization can greatly increase the costs associated with configuring remote devices.

SUMMARY OF THE INVENTION

A method for configuring a device is disclosed which uses server responses to transport configuration data to the device. A system according to the present teachings includes a device that transfers a request message via a communication network and a configuration server that receives the request message via the communication network and in response transfers a response message to the device via the communication network wherein the response message includes a set of configuration data for the device.

Other features and advantages of the present invention will be apparent from the detailed description that follows.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention is described with respect to particular exemplary embodiments thereof and reference is accordingly made to the drawings in which:

Figure 1 shows an arrangement for configuring a device according to the present teachings;

Figure 2 illustrates a method for configuring a device according to the present teachings;

Figure 3 shows an arrangement that enables a user at a workstation to configure the device according to the present teachings;

Figure 4 shows an arrangement for configuring a set of devices according to the present teachings.

DETAILED DESCRIPTION

Figure 1 shows an arrangement for configuring a device 14 according to the present teachings. The device 14 is capable of a set of behaviors which are governed by configuration data. The configuration data for the device 14 is obtained from a configuration server 10 via a communication network 100.

In one embodiment, the communication network 100 may be the world-wide web of the Internet. Alternatively, the communication network 100 may be another communication network which supports the Hyper-Text Transfer Protocol (HTTP). In other embodiments, other client-server communication protocols may be employed.

In one embodiment, the device 14 is protected from unauthorized accesses by a firewall 12. In another embodiment, the device 14 connects to the communication network 100 without a firewall.

The firewall 12 deflects communication transactions that originate on the communication network 100 from reaching the device 14. For example, the firewall 12 deflects HTTP GET and HTTP POST commands, etc. that initiate with the configuration server 10. This prevents the configuration server 10 from initiating a transfer of configuration data to the device 14 via the communication network 100 without some specialized configuration of the firewall 12.

The firewall 12 allows communication transactions that originate with the device 14 to reach the communication network 100. For example, the firewall 12 allows HTTP GET and HTTP POST commands, etc. from the device 14 to reach the communication network 100. The firewall 12 also allows server responses from the communication network 100 to pass back through to the device 14 for communication transactions that were initiated by the device 14. This allows the device 14 to request configuration data from the configuration server 10 by generating an HTTP POST command request and obtain the configuration data in a response to the HTTP POST command request. In an alternative embodiment, the device 14 requests configuration data from the configuration server 10 by generating an HTTP GET command request and obtains the configuration data in a response to the HTTP GET command request.

The device 14 may be any device which is capable of behaviors that are governed by configuration data. For example, the device 14 may include sensor/measurement behaviors, actuator/stimulus behaviors, or device control behaviors or any combination of these. Examples of actuator/stimulus behaviors include signal generators, heaters, mechanical actuators, devices that apply chemical stimuli, etc. Examples of sensor/measurement behaviors include temperature sensors, humidity sensors, chemical sensors, mechanical movement sensors, signal receivers, etc. Examples of device control behaviors include electrical, chemical, mechanical system controllers.

The device 14 is capable of communication according to the HTTP prtocol. The device 14 includes the hardware/software elements for performing HTTP communication via the communication network 100 as an HTTP client. The device 14 may include the functionality of an HTTP server. Alternatively, the device 14 may be attached to a separate device which is capable of HTTP communication.

Figure 2 illustrates a method for configuring the device 14 through the firewall 12 according to the present teachings. The device 14 generates a request message 20 that specifies the configuration server 10 and transfers the request message 20 through the firewall 12 and on to the configuration server 10 via the communication network 100. The request message 20 includes a set of device data 22.

In one embodiment, the request message 20 is an HTTP Post command request which specifies the configuration server 10 using a uniform resource locator (URL) associated with the configuration server 10. The device data 22 may be embedded in the forms data associated with the HTTP POST command according to the HTTP protocol.

The device data 22 may be data which is generated by the device 14 when performing one or more of its behaviors. In such a case the device 14 uses the request message 20 to provide data generated by its behaviors back to the configuration server 10. The configuration server 10 may log the device data

22, relay the device data 22 onto another node or device, or use the device data 22 to determine new configuration data for the device 14 or perform any combination of these functions.

For example, the device 14 may be a sensor which may be configured to obtain measurements at periodic intervals and/or at particular times and/or under particular conditions. The device 14 may perform measurements on a system (not shown) or perform measurements to monitor environmental conditions at a remote site. The device 14 may use the request message 20 to report obtained measurements back to the configuration server 10 as the device data 22. The device data 22 may include multiple sets of measurement data depending on how the device 14 is configured.

In another example, the device 14 may perform an error checking and/or alarm function. The device 14 may use the request message 20 to report errors and/or alarms back to the configuration server 10 and specify the error/alarm with the device data 22.

The device data 22 may carry a heartbeat indication which is generated periodically by the device 14 and sent in a request to inform the configuration server 10 that the device 14 is alive and functioning. The period with which the device 14 generates the heartbeat indication may be configured by the configuration server 10.

The device 14 may generate the request message 20 in response to a page from the configuration

server 10 or page from some other device. The device 14 may have a receiver for the page or may have an external pager that notifies the device 14 when a page message is received.

The configuration server 10 responds to the request message 20 by generating a response message 30 and transferring it back to the device 14 via the communication network 100. The response message 30 includes a set of configuration data 32. The response message 30 passes through the firewall 12 to the device 14 as a normal response to the request message 20 which initiated the communication transaction with the configuration server 10. In one embodiment, the response message 30 includes an acknowledgment to the HTTP POST according to the HTTP protocol and also includes the configuration data 32.

The configuration data 32 provides configuration information pertaining to the behaviors of the device 14. The configuration data 32 may specify a heartbeat period for the device 14. The configuration data 32 may specify a time or times or time intervals at which the device 14 is to obtain measurements and/or apply a stimulus and/or perform some other behavior. The configuration data 32 may identify the type or types of measurements to be obtained by the device 14. The configuration data 32 may identify the type or types of stimuli to be applied by the device 14.

The configuration data 32 may include any parameter associated with measurement behaviors and/or stimulus behaviors and/or control behaviors of the device 14. For example, if the device 14 is a signal generator then the configuration data 32 may include parameters associated with amplitudes, frequencies, periods, etc. of signals generated by the device 14.

The device 14 extracts the configuration data 32 from the response message 30 and interprets the commands and associated data in the configuration data 32 to alter its configuration. For example, commands and associated data in the configuration data 32 may be interpreted to write data to specified registers in the device 14 that control its behaviors.

Figure 3 shows an arrangement that enables a user at a workstation 50 to configure the device 14 according to the present teachings. A user at the workstation 50 enters set of new configuration data 62 for the device 14. The new configuration data 62 may be arranged as commands and associated parameters which are to be interpreted and executed by a processor in the device 14.

The workstation 50 transfers the new configuration data 62 to the configuration server 10 in a message 60. The message 60 may be transferred to the configuration server 10 via the communication network 100 or via some other communication path between the workstation 50 and the configuration

server 10. Alternatively, a user may provide the new configuration data 62 to the configuration server 10 using HTTP protocols. For example, the configuration server 10 may generate one or more web pages for configuring the device 14 and the workstation 50 as an HTTP client may access these web pages to enter the new configuration data 62.

The communication server 10 obtains the new configuration data 62 and stores it as a set of pending configuration data 54 for the device 14. The communication server 10 also sets a configuration pending indicator 52 when the new configuration data 62 is obtained from the workstation 50.

If the configuration pending indicator 52 is set when the request message 20 is received from the device 14, the configuration server 10 clears the configuration pending indicator 52 and reads the pending configuration data 54 and sends it back to the device 14 in the response message 30 as the configuration data 32. Otherwise, the configuration server 10 provides the normal acknowledgment to the request message 20 according to HTTP protocols.

Figure 4 shows an arrangement for configuring the device 14 and a set of devices 40-42 according to the present teachings. The device 14 and the devices 40-42 communication with each other via a local network 120. In one embodiment, the device 14 and the devices 40-42 are all behind the firewall 12 which deflects communication transactions that originate on the communication network 100 from

reaching the local network 120. In another embodiment, the local network 120 connects to the communication network 100 through a communication device other than a firewall.

The device 14 generates the request message 20 to the configuration server 10 and obtains the response message 30. The response message 30 to the device 14 in this arrangement may include a configuration change message that specifies one of the devices 40-42. For example, the configuration change message may specify the IP address of one of the devices 40-42. The configuration server 10 includes the configuration change message in the request message 20 because it has pending configuration data for the device targeted by the configuration change message. The device 14 forwards the configuration change message to the appropriate one of the devices 40-42. The configuration change message may be sent between the devices 14, 40-42 using HTTP protocols. The configuration change message causes the device 40-42 that receives it to generate its own request message to the configuration server 10 for updated configuration data as described above.

The device 14 and the devices 40-42 periodically generate requests to the communication server 10 that include the heart beat indication. The scheduling of requests that include the heartbeat indication may be staggered evenly in time among the device 14 and the devices 40-42. For example, if there are a total of 10 devices on the local network 120 and each one

generates a request with a heartbeat indication once every 10 minutes in a staggered schedule then the configuration server 10 is contacted once per minute, thereby giving the configuration server 10 an opportunity to send configuration data immediately to a device or cause a device with pending configuration data to send a request message to the configuration server. This reduces the configuration change delay for the devices from 10 minutes to 1 minute.

Alternatively, the devices on the local network 120 may be configured to generate requests with heartbeat indications at random times. For example, if 10 devices are configured to generate heartbeats once every 100 minutes with each device starting at some random time, the configuration server 10 would be contacted on average once every 10 minutes.

The following is an example implementation of request/response interactions between the device 14 and the server 10 in one embodiment. Numerous alternative implementations are possible according to the present teachings.

In one embodiment, the device 14 notifies the configuration server 10 that it is starting up with a registration message (operationID="7168") and a request for the current time (operationID="7202"). The following is an example of a registration message and a request for the current time using an HTTP POST command request.

```
POST /node HTTP/1.0
Host: 141.121.199.149:8088
Connection: close
```

```
    Content-Type: multipart/form-data;
boundary=--------------------------7d01670fa06b2
    Content-Length: 1182
    X-yzzy: xxxxxx

    ----------------------------7d01670fa06b2
    Content-Disposition: form-data; name="xml";
    Content-Type: text/xml
    Content-Encoding: X-ESP
    Content-Length: 956
    X-yzzy: xxxxxxx

    3.\.....<?xml version="1.0" ?>
    <!DOCTYPE MessageArray SYSTEM "dot1v1.dtd">
    <MessageArray
sourceID="03001083044326000000000000000000001">
    <Message msgID="030010830443263b1fed3d1640056f006c">
    <Client objectID="0"
        operationID="7168"
        execMode="return">
    <ArgArray length="12">
    <OctetArray>001083044326</OctetArray>
    <OctetArray>8d79c711</OctetArray>

<ObjectID>03001083044326000000000000000000001</ObjectID>
    <String>ROM B.04.10 , BOOT A.02.13, HW
rigel:0x00000001</String>
    <String>Agilent</String>
    <String>DMC_NCAPBlock</String>
    <String>1.01</String>
    <String>US00324</String>
    <String>wks00005</String>
    <String>Lake Stevens - glenne</String>
    <String>0.0.0.0</String>
    <String>255.255.252.0</String>
    </ArgArray>
    </Client>
    </Message>
    <Message msgID="030010830443263b1fed3d166d6a87006c">
    <Client objectID="0"
        operationID="7202"
        execMode="return">
    <ArgArray length="0">
    </ArgArray>
    </Client>
    </Message>
    </MessageArray>
    ....F`.1C.......
    ----------------------------7d01670fa06b2--
```

The following is an example acknowledgment of the registration and the current time request

generated by the configuration server 10 and sent back to the device 14.

```
    HTTP/1.1 200 OK
    Server: WebLogic 5.1.0 Service Pack 8 12/20/2000
16:34:54 #95137
    Content-Encoding: X-ESP
    Content-Length: 772
    Content-Type: text/xml
    Connection: Close

    3.\.....<?xml version="1.0" ?>
    <!DOCTYPE MessageArray SYSTEM "/dot1v1.dtd">
    <MessageArray version="1">
    <Message msgID="030010830443263b1fed3d1640056f006c">
    <Server csReturnCode="0" execMode="return">
    <ArgArray length="0">

    </ArgArray>
    </Server>
    </Message>
    <Message msgID="030010830443263b1fed3d166d6a87006c">
    <Server csReturnCode="0" execMode="return">
    <ArgArray length="1">
    <TimeRepresentation seconds="991948142"
nanoseconds="0">
    </TimeRepresentation>
    </ArgArray>
    </Server>
    </Message>
    </MessageArray>.....................
```

The following is an example of a data publication to the configuration server 10 generated by the device 14.

```
    POST /node HTTP/1.0
    Host: 141.121.199.149:8088
    Connection: close
    Content-Type: multipart/form-data;
boundary=----------------------------7d01670fa06b2
    Content-Length: 1622
    X-yzzy: xxxxxx

    ----------------------------7d01670fa06b2
    Content-Disposition: form-data; name="xml";
    Content-Type: text/xml
    Content-Encoding: X-ESP
    Content-Length: 1396
    X-yzzy: xxxxxx
```

```
    3.\...."<?xml version="1.0" ?>
    <!DOCTYPE MessageArray SYSTEM "dot1v1.dtd">
    <MessageArray
sourceID="03001083044326000000000000000000001">
    <Message msgID="030010830443263b1fef1000699f8a006c">
    <Publication topic="data.wks00005.Antenna.swptRtnLoss"
pubID="0" pubKey="0" hash="0">
    <ArgArray length="4">
    <Float32>22.98185539</Float32>
    <TimeRepresentation seconds="991948560"
nanoseconds="962672"/>

<ObjectID>030010830443263b1fea9628b12fe4006a</ObjectID>
    <TimeRepresentation seconds="991948560"
nanoseconds="0"/>
    </ArgArray>
    </Publication>
    </Message>
    </MessageArray>
    .....Pr..M.....r.
    ----------------------------7d01670fa06b2--
```

If the configuration server 10 has a configuration change pending it replies to the device 14 with a query for a checksum of the reporter.ini file (operationID="7205") as follows.

```
    HTTP/1.1 200 OK
    Server: WebLogic 5.1.0 Service Pack 8 12/20/2000
16:34:54 #95137
    Content-Encoding: X-ESP
    Content-Length: 388
    Content-Type: text/xml
    Connection: Close

    3.\....#<?xml version="1.0" ?>
    <!DOCTYPE MessageArray SYSTEM "/dot1v1.dtd">
    <MessageArray version="1">
    <Message msgID="3f95">
    <Client objectID="03001083044326000000000000000000001"
operationID="7205" execMode="return">
    <ArgArray length="3">

<Int32>4</Int32><String>/registry/reporter.ini</String><Oc
tetArray></OctetArray>
    </ArgArray>
    </Client>
    </Message>
    </MessageArray>.........Ds=(.3[S.a
```

The device 14 connects to configuration server 10 to reply to the reporter.ini request as follows.

```
POST /node HTTP/1.0
Host: 141.121.199.149:8088
Connection: close
Content-Type: multipart/form-data;
boundary=----------------------------7d01670fa06b2
Content-Length: 614
X-yzzy: xxxxxxx

----------------------------7d01670fa06b2
Content-Disposition: form-data; name="xml";
Content-Type: text/xml
Content-Encoding: X-ESP
Content-Length: 388
X-yzzy: xxxxxxx

3.\....$<?xml version="1.0" ?>
<!DOCTYPE MessageArray SYSTEM "dot1v1.dtd">
<MessageArray
sourceID="03001083044326000000000000000000001">
<Message msgID="3f95">
<Server csReturnCode="0" >
<ArgArray length="1">
<ArgArray length="3">
<String>/registry/reporter.ini</String>
<UInt32>525</UInt32>
<Int32>42379</Int32>
</ArgArray>
</ArgArray>
</Server>
</Message>
</MessageArray>
.....T.%O......
----------------------------7d01670fa06b2--
```

The configuration server 10 replies with a file transfer to the device 14 ("operationID=7205") as follows.

```
HTTP/1.1 200 OK
Server: WebLogic 5.1.0 Service Pack 8 12/20/2000
16:34:54 #95137
Content-Encoding: X-ESP
Content-Length: 1460
Content-Type: text/xml
Connection: Close

3.\....%<?xml version="1.0" ?>
```

```
<!DOCTYPE MessageArray SYSTEM "/dot1v1.dtd">
<MessageArray version="1">
<Message msgID="3f96">
<Client objectID="0300108304432600000000000000000001"
operationID="7205" execMode="return">
<ArgArray length="3">

<Int32>2</Int32><String>/registry/reporter.ini</String>
<OctetArray>7061636b6167653d7265706f727465720d0a6175746f53
746
172743d310d0a6f626a49443d303330303130383330343433323630303
030
303030303030303030303030303130310d0a7461736b5072696f726974
793
d34300d0a70726f78793d3133302e32392e3233362e3230340d0a70726
f78
79506f72743d38300d0a75726c3d2f6e6f64650d0a7265706f7274496e
746
57276616c3d36300d0a70726f78794c6f67696e3d0d0a70726f7879506
173
73776f72643d0d0a6d61784e756d446174756d3d300d0a7265706f7274
4f6
e44656d616e643d300d0a6e756d537562733d340d0a73312e7175616c3
d64
6174612e776b7330303030352e2a0d0a73322e7175616c3d6f642e776b
733
0303030352e2a0d0a73332e7175616c3d77642e776b7330303030352e2
a0d0a73342e7175616c3d77652e776b7330303030352e2a0d0a6368656
36b696e54696d653d310d0a726574727944656c61793d31300d0a72657
472794d756c743d320d0a72657472794d61783d36300d0a6d756c74697
06172743d310d0a736563456e636f64696e673d4553502c484d41432d4
d44352c4e554c4c0d0a7370693d383731393134373135 0d0a617574684
b65793d353737353739643237386536336464336438643665663364663
93861353766360d0a617574684b6579426974733d3132380d0a656e634
b65793d0d0a656e634b6579426974733d300d0a7365714e756d3d31313
43638380d0a</OctetArray>
</ArgArray>
</Client>
</Message>
</MessageArray>.............c.$XJ...
```

The device 14 connects to configuration server 10 to acknowledge receipt of the reporter.ini file as follows.

```
POST /node HTTP/1.0
Host: 141.121.199.149:8088
Connection: close
Content-Type: multipart/form-data;
boundary=--------------------------7d01670fa06b2
Content-Length: 498
X-yzzy: xxxxxxx
```

```
------------------------------7d01670fa06b2
Content-Disposition: form-data; name="xml";
Content-Type: text/xml
Content-Encoding: X-ESP
Content-Length: 272
X-yzzy: xxxxxxx

3.\....&<?xml version="1.0" ?>
<!DOCTYPE MessageArray SYSTEM "dot1v1.dtd">
<MessageArray
sourceID="03001083044326000000000000000000001">
<Message msgID="3f96">
<Server csReturnCode="0" >
<ArgArray length="0">
</ArgArray>
</Server>
</Message>
</MessageArray>
.....I...].'...
------------------------------7d01670fa06b2--
```

The foregoing detailed description of the present invention is provided for the purposes of illustration and is not intended to be exhaustive or to limit the invention to the precise embodiment disclosed. Accordingly, the scope of the present invention is defined by the appended claims.